Biometric Cyber Pen

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Abstract

Increasing reliance on digital storage for personal, financial, medical, and policy information results in a greater demand for robust digital authentication and cybersecurity protection measures. We are developing a new digital authentication method that utilizes an individual's signature. Thus, we design a writing stylus which classifies inertial measurement features for user identification. The current prototype consists of two triaxial accelerometers, one mounted at each of the stylus' terminal ends. Features extracted from how the pen is held, stroke styles, and writing speed can affect the stylus tip accelerations which leads to a unique signature detection and to deter forgery. Novel, manual spatiotemporal features relating to such metrics were proposed and a multi-layer perceptron was utilized for binary classification.

Motivation

Security is a growing concern in today's technology-driven world. Several methods of authentication exists however all common practices have their own drawbacks. We present a novel method of user authentication via their signature.

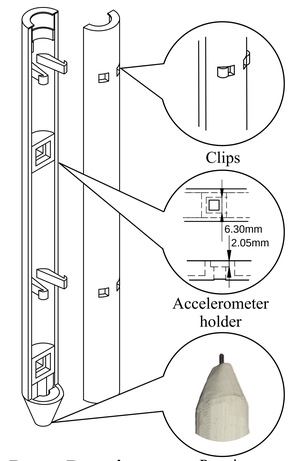
Security feature	Drawback
Alpha-numeric passwords	Can be brute forced
Multi-factor authentication	Requires network connection
Biometric ID	Can be unreliable at times

Proposed Solution

An individual's signature is unique in the way they hold the pen, the speed and angle which they write their name, and which parts of letter they flourish. Those distinct features make it difficult for another person to copy exactly despite the end result looking similar. By not just focusing on the end result but the entirety signature writing process, the pen will be able to tell whether the signature is forged or authentic.

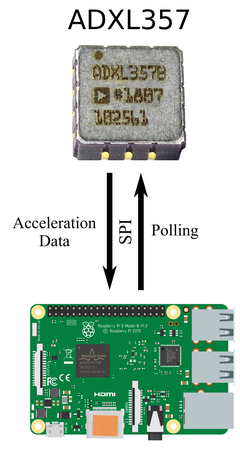
Authentic Signature	Forged Signatures	
		

Hardware



Pen Design

ADXL357



Raspberry Pi

Workflow

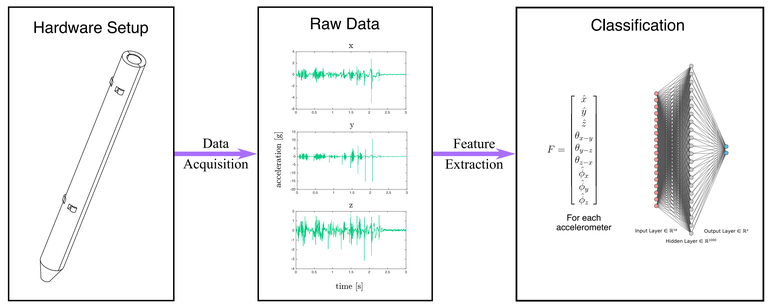


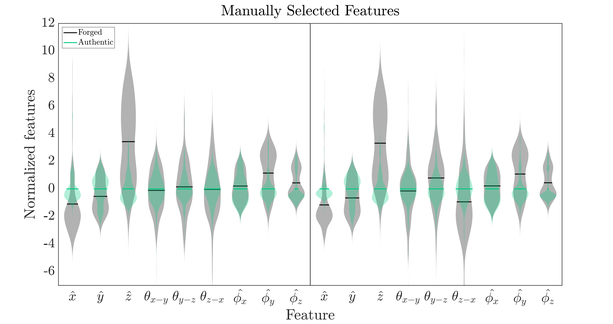
Fig: Flowchart of sensorized writing stylus authentication scheme. ADXL357 accelerometers are mounted to a writing stylus, and raw data is continually logged for feature extraction and neural network training. Once training is complete, the user will utilize the sensorized stylus, and real-time inertial data is processed via the trained perceptron network for authentication.

Feature Extraction

$$\hat{i} = \frac{1}{N}\sum_t a_i(t)$$

$$\theta_{i-j} = \arctan\left(\frac{a_{i_{RMS}}}{a_{j_{RMS}}}\right)$$

$$\hat{\phi}_i = \arg\left(\frac{1}{N}\sum_t a_i(t)\cdot\exp\left(2\pi\frac{t}{T}\right)\right)$$



Data Collection

The accelerometer data was sampled at around 2kHz, and was downsampled via interpolation to 1kHz.

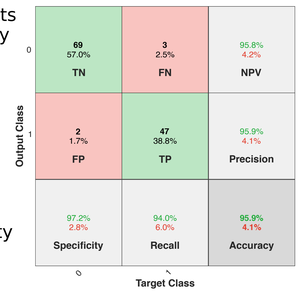
There were 8 participants in this study and they each forged 30 signatures with an additional 15 scribbles or random words.

In addition to this, 200 authentic signatures were taken.

Results

Classification results show the specificity of 97.2% which assuring mininal chances of false authentification, which is essential for security authentication.

Recall rate of 94% allows for variability in user signatures



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